

W9132T-04-C-0014

Flint Electric Membership Corporation

Final Project Report

Proton Exchange Membrane (PEM) Fuel Cell Demonstration
of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY04

Luther H. Story Recreational Building #3308
Fort Benning Army Post
Fort Benning, Georgia

April 16, 2007

Executive Summary

One PEM fuel cell is used in the demonstration project at the Luther H. Story Recreation Center, Building 3308, Fort Benning, Georgia. The manufacturer of the fuel cell is Plug Power. The unit is rated at approximately 5 kilowatts and has been set at 2.5 kilowatts for the duration of the test. The fuel cell has utilized natural gas as a stock and has been grid connected. The heat byproduct has been captured and used to produce domestic hot water. The building to which the fuel cell is providing AC electrical energy is used as a recreational building for Army recruits assigned to the Sand Hill Area. The energy provided by the fuel cell is only a fraction of that required by the building. The host site individual is Benny Hines, Utility Contract Sales and Service, Fort Benning, Georgia (706-545-4310).

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Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 Descriptive Title

A one year demonstration project utilizing a fuel cell unit.

Luther H. Story Recreational Building #3308
Fort Benning Army Post
First Infantry Street
Fort Benning, Georgia 31905

2.0 Name, Address and Related Company Information

Name: Flint Electric Membership Corporation
Address: 3 S. Macon Street, Reynolds, Georgia 31076
Phone Number: (478) 988-3500
Data Universal Numbering System (DUNS) Number: 00-692-6349
Commercial and Government Entity (CAGE) Code: OJWD8
Taxpayer Identification Number (TIN): 58-0456574

Flint Electric Membership Corporation (DBA Flint Energies) is a non profit electrical distribution cooperative.

3.0 Production Capability of the Manufacturer

G.E. Fuel Cell Systems, LLC
968 Albany-Shaker Road
Building 1
Latham, NY 12110
(518) 785-2824

Provide technical support, parts, warranty.
Unit is experimental and not commercially available.

4.0 Principal Investigator(s)

Principal Investigator(s)
Name: Jim Atkinson
Title: Power Distribution Technician
Company: Flint Energies
Phone: (706) 682-4488
Fax: (706) 682-4490
Email: jatkinson@flintemc.com

5.0 Authorized Negotiator(s)

Authorized Negotiator(s)

Name: F. Ronnie Sanders
Title : V. President Military & Community Affairs
Company: Flint Electric Membership Corporation
Phone: (478) 988-3931
Fax: (478) 988-3526
Email: rsanders@flintemc.com

Name: Robert Ray Jr.
Title : President/CEO
Company: Flint Electric Membership Corporation
Phone: (478) 847-5114
Fax: (478) 847-5173
Email: bray@flintemc.com

6.0 Past Relevant Performance Information

Installed 5.0 kw fuel cell at Flint Energies Service Center, 900 Hwy 96, Warner Robins, Georgia
Unit installed June, 2002.
Operation 10 months.
Unit availability approximately 85%.

Plug Power Model SU1PCM-059622

7.0 Host Facility Information



Fort Benning was established in 1918. Known as the "Home of the Infantry", the installation spreads over 182,000 acres and is home to the U.S. Army Infantry Training Brigade, U.S. Infantry School, Ranger Training Brigade, Airborne School, and School of the Americas.



The Luther H. Story Recreation Center is located in the Sand Hill Area of Fort Benning, Georgia. It is used as a recreational center for Army recruits. Flint Energies owns and operates the electric facilities that serve the Fort Benning installation. The electric commodity is provided by Georgia Power Company.

8.0 Fuel Cell Installation



Flint Electric Membership Corporation owned and maintained the electrical facilities on post. The electric commodity was provided by Georgia Power Company. Natural Gas was supplied by Atmos Energy. Communications lines were provided by Southern Bell. The building electrical and natural gas consumption/costs can be obtained from Benny Hines, Utility Contract Sales and Service, Fort Benning, Georgia.

Location of the fuel cell was on the north side and close to the mechanical room of the Luther H. Story Recreation Center, Building 3308. There was a panel mounted on the outside wall of the mechanical room. This panel was installed to feed the exterior lighting for the building. Power was fed from the unit into this panel, which then fed the grid. The fuel cell was capable of stand-alone operation, but this feature was not considered for this demonstration.

The unit was a GenSys 5KW fuel cell power plant. The unit was operated at 2.5KW for the duration of the demonstration.

A source of natural gas was readily available, as were water, drains and communication lines inside the mechanical room.

NEMA 4 boxes were mounted on a rack to house the necessary disconnect switch, as well as external metering apparatus.

The unit was commissioned on September 14, 2005 by procedures published by Plug Power Inc. under Section 5.0 (Unit Checkout and Commissioning). Project installation was completed in approximately three weeks.

9.0 Electrical System

The fuel cell provided 2.5kw of power, at 120 volts AC output. The unit was connected directly to the grid owned and operated by Flint Electric Membership Corporation, through the building's electrical service entrance. No specific loads were designated to be exclusively supplied by the fuel cell. The heat recovered from the fuel cell was used to provide a portion of the domestic hot water for the building.

There was a panel mounted on the outside wall of the mechanical room that fed the exterior lighting for the building. Power was fed from the unit into this panel, which then fed the electrical grid.

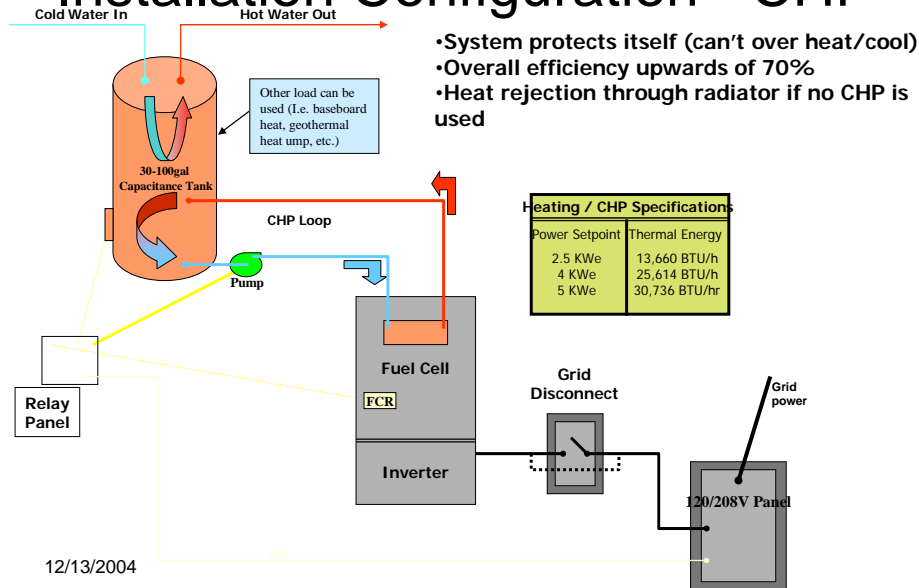
During the scope of this report the unit was running at 93% availability.

10.0 Thermal Recovery System

The Customer Option for Combined Heat and Power (CHP) required a facility heat load and customer supplied heat transfer system. The heat load was the hot water loop in the building. The FCS had external connections for the customer system. Two of these connections were for plumbing. A 1-inch copper pipe was installed from these to a heat exchanger that was mounted in the mechanical room. From the heat exchanger two 1-inch copper pipes were installed in the hot water system in the building.

The other connections of the CHP modification were intended to provide a signal to the end user that indicated whether or not the FCS was ready to provide heat. This signal prevented the user from running pumps that were installed when heat from the CHP loop was not available. A relay installed in the inverter cabinet was connected to the Power Distribution Board. The Power Distribution Board energized the relay based on a SARC command. The SARC determined system readiness to provide excess heat based on a control algorithm and system parameters. The CHP relay was controlled by the Stack and Reformer Controller (SARC) through the Power Distribution Board (PDB).

Installation Configuration - CHP



This illustration demonstrates a thermal recovery system. The cold water goes into the unit and picks up heat from the heat exchanger and the hot water flows into the hot water storage tank.

11.0 Data Acquisition System

The data connection was via a modem and a dedicated telephone line. Operation of the unit (changes in operating points) was accomplished through the connection of a desktop computer located in the mechanical room running the manufacturer's Technician Software. The unit automatically transferred "System Log Files" to the manufacturer on a daily basis, and transferred error files in the event of a shutdown. In the event of a shutdown an alarm would be sent via modem to the Principal Investigator. Plug Power collected data in Latham, NY and sent this information to Flint on a weekly basis.

As a minimum, the parameters monitored included total operating hours, fuel input, total kw hours (kWh) produced, availability, outages and duration (start/stop events with associated dates and times), maximum kw produced, outdoor ambient temperature, and total heat recovered. Data was collected hourly and raw data was submitted monthly.

12.0 Fuel Supply System

The type of fuel used by the fuel cell was natural gas. The local gas utility (Atmos) tapped the gas main that fed the building, ran a line to the unit, and set a meter to measure gas consumption. A plumber then ran a line from the meter to the unit. No significant problems were encountered during the installation of the fuel supply system. There have been no fuel supply issues of any type during the scope of this project.

13.0 Program Costs

	Actual Costs	Estimated Costs
System Purchase Cost	\$ 75,298.00	\$ 75,298.00
Installation	61,678.00	57,000.00
Performance Monitoring	1,000.00	1,500.00
Maintenance (labor, materials, etc.)	2,000.00	4,000.00
Project Management/Report Writing	1,500.00	1,200.00
Travel	1,000.00	800.00
Decommissioning/Site Restoration	3,000.00	3,000.00
Total	\$ 145,476.00	\$ 142,798.00

The unit operated at a much greater availability than was expected. The installation costs were higher than expected due to installation requirements that were not anticipated. The project was expected to have a higher maintenance cost. However with a better available running time (low outage time), the maintenance costs were less.

14.0 Milestones/Improvements

During the operation period from November, 2005 through October, 2006 (12 months) the unit ran a total of 8,163 hours. The total availability during this period was 93%. There was one scheduled outage totaling 8 hours. There were 6 unscheduled outages totaling 9 hours.

15.0 Decommissioning/Removal/Site Restoration

All utilities (electrical, telephone, water, gas) have been removed from the building. All penetrations for the utilities have been restored to original.

The fuel cell and pad along with information placards (shown below) have been left on site for an indefinite period of time for demonstration/educational purposes.



16.0 Additional Research/Analysis

N/A

17.0 Conclusions/Summary

Total Contract Cost	\$160,514.00
Total Program Cost	\$145,476.00

Appendix

Fuel Cell Site Grand Totals

Run Time (Hours)	8163
Time in Period (Hours)	8760
Availability (%)	93.18%
Energy Produced (kWe-hrs AC)	19145
Output Setting (kW)	2.50
Average Output (kW)	2.35
Capacity Factor (%)	0.44
Fuel Usage, HHV (BTUs)	2.63E+08
Fuel Usage (SCF)	351500
Electrical Efficiency (%)	24.83%
Thermal Heat Recovery (BTUs)	8865000
Heat Recovery Rate (BTUs/hour)	1086.00
Thermal Efficiency (%)	3.37%
Overall Efficiency (%)	28.20%
Number of Scheduled Outages	1
Scheduled Outage Hours	8
Number of Unscheduled Outages	6
Unscheduled Outage Hours	9

Outage/Maintenance History:

- Scheduled
 - May 10, 2006 - (12,000 kwh maintenance)
 - June 28, 2006 - (Replace filters- 8 hours)
- Unscheduled
 - January 2, 2006 - (Changed RO filter- 2 hours)
 - March 27, 2006 - (Reset Comm port)
 - June 21, 2006 - (Humidifier water level low- 1 hour)
 - June 22, 2006 - (Low output from DI water panel – 1 hour)
 - June 28, 2006 - (Level 5 humidifier low – 1 hour)
 - June 28, 2006 - (Replaced filters)
 - September 1, 2006 - Hardware Failure – 2 hours)
 - September 21, 2006 - Humidifier level low – 2 hours)